

IN THE CLAIMS:

Please add claims 53 - 68.

Claims 1 - 10 (cancelled).

11. (original) A stereo echo canceller associated to a space provided therein with two loudspeakers and two microphones for forming four audio transfer systems through which stereo sounds are reproduced by said respective loudspeakers and are collected by said respective microphones,

the canceller comprising: first and second filter sections that are provided corresponding to the first and second microphones for subjecting an audio signal supplied to the first loudspeaker to convolution calculations so as to produce first and second echo cancel signals, respectively;

third and fourth filter sections that are provided corresponding to the first and second microphones for subjecting another audio signal supplied to the second loudspeaker to convolution calculations so as to produce third and fourth echo cancel signals, respectively;

a first subtracting section that performs echo cancellation by subtracting said first and third echo cancel signals from a collected audio signal of the first microphone; and

a second subtracting section that performs echo cancellation by subtracting said second and fourth echo cancel signals from another collected audio signal of the second microphone, wherein

said stereo echo canceller further comprises a transfer function calculating section that respectively derives filter characteristics corresponding to transfer functions of said four audio transfer systems based on a cross-spectrum calculation between a

sum signal and difference signal of stereo audio signals to be reproduced by said respective loudspeakers and the collected audio signals of said respective microphones, thereby to set said derived filter characteristics to corresponding ones of said first to fourth filter sections, respectively.

12. (original) A stereo echo canceller as recited in claim 11, further comprising:  
an input section that inputs said stereo audio signals;  
a sum/difference signal producing section that produces said sum signal and said difference signal of the stereo audio signals inputted from said input section; and  
a main signal transmission system that transmits the stereo audio signals inputted from said input section to said respective loudspeakers without passing through said sum/difference signal producing section,

wherein said transfer function calculating section derives the filter characteristics corresponding to the transfer functions of said four audio transfer systems based on the cross-spectrum calculation between the sum signal and difference signal produced by said sum/difference signal producing section and the collected audio signals of said respective microphones, and sets the derived filter characteristics to corresponding ones of said first to fourth filter sections, respectively.

13. (original) A stereo echo canceller associated to a space provided therein with two loudspeakers and two microphones for forming four audio transfer systems through which stereo sounds are reproduced by said respective loudspeakers and are collected by said respective microphones,

the canceller comprising: first and second filter sections that are provided corresponding to the first and second microphones for subjecting an audio signal

supplied to the first loudspeaker to convolution calculations so as to produce first and second echo cancel signals, respectively;

third and fourth filter sections that are provided corresponding to the first and second microphones for subjecting another audio signal supplied to the second loudspeaker to convolution calculations so as to produce third and fourth echo cancel signals, respectively;

a first subtracting section performs echo cancellation by subtracting said first and third echo cancel signals from a collected audio signal of the first microphone; and

a second subtracting section that performs echo cancellation by subtracting said second and fourth echo cancel signals from another collected audio signal of the second microphone, wherein

said stereo echo canceller further comprises a transfer function calculating section respectively derives estimated errors of transfer functions of said four audio transfer systems based on a cross-spectrum calculation between respective one of a sum signal and a difference signal of stereo audio signals to be reproduced by said respective loudspeakers and respective one of echo cancel error signals obtained by subtracting the corresponding echo cancel signals from the collected audio signals of said two microphones, thereby to update filter characteristics of said first to fourth filter sections to values that cancel said estimated errors, respectively.

14. (original) A stereo echo canceller as recited in claim 13, further comprising:

an input section that inputs said stereo audio signals;

a sum/difference signal producing section that produces said sum signal and said difference signal of the stereo audio signals inputted from said input section; and

a main signal transmission system that transmits the stereo audio signals inputted from said input section to said respective loudspeakers without passing through said sum/difference signal producing section,

wherein said transfer function calculating section derives the estimated errors of the transfer functions of said four audio transfer systems based on the cross-spectrum calculation between the sum signal and difference signal produced by said sum/difference signal producing section and the respective echo cancel error signals, and updates the filter characteristics of said first to fourth filter sections to the values that cancel said estimated errors, respectively.

15. (original) A stereo echo canceller as recited in claim 13, further comprising a correlation detecting section that detects a correlation between the sum signal and the difference signal of said stereo audio signals, and that stops the updating of said filter characteristics when a value of said correlation is no less than a predetermined value.

16. (original) A stereo echo canceller associated to a space provided therein with two loudspeakers and two microphones for forming four audio transfer systems, the canceller comprising:

an input section that inputs audio signals of stereo sounds from an outside, which are reproduced by said respective loudspeakers and collected by said respective microphones through the audio transfer systems;

first and second filter sections that is provided corresponding to the first and second microphones for subjecting an audio signal supplied to the first loudspeaker to convolution calculations so as to produce first and second echo cancel signals,

respectively;

third and fourth filter sections that are provided corresponding to the first and second microphones for subjecting another audio signal supplied to the second loudspeaker to convolution calculations so as to produce third and fourth echo cancel signals, respectively;

a first subtracting section that performs echo cancellation by subtracting said first and third echo cancel signals from a collected audio signal of the first microphone; and

a second subtracting section that performs echo cancellation by subtracting said second and fourth echo cancel signals from another collected audio signal of the second microphone, wherein

said stereo echo canceller further comprises a transfer function calculating section respectively derives filter characteristics corresponding to transfer functions of said four audio transfer systems based on a cross-spectrum calculation between said collected audio signals of said respective microphones and mutually orthogonal two uncorrelated composite signals produced by applying a principal component analysis to stereo audio signals to be reproduced by said respective loudspeakers, thereby to set said derived filter characteristics to corresponding ones of said first to fourth filter sections, respectively.

17. (original) A stereo echo canceller as recited in claim 16, further comprising:  
an orthogonalizing section that applies said principal component analysis to the stereo audio signals inputted from said input section to produce said mutually orthogonal two uncorrelated composite signals; and  
a main signal transmission system that transmits the stereo audio signals

inputted from said input section to said respective loudspeakers without passing through said orthogonalizing section,

wherein said transfer function calculating section derives the filter characteristics corresponding to the transfer functions of said four audio transfer systems based on the cross-spectrum calculation between the two uncorrelated composite signals produced by said orthogonalizing section and the collected audio signals of said respective microphone, and sets the derived filter characteristics to corresponding ones of said first to fourth filter sections, respectively.

18. (original) A stereo echo canceller associated to a space provided therein with two loudspeakers and two microphones for forming four audio transfer systems, the canceller comprising:

an input section that inputs stereo audio signals from an outside, which are reproduced by said respective loudspeakers and collected by said respective microphones through the audio transfer systems;

first and second filter sections that are provided corresponding to the first and second microphones for subjecting an audio signal supplied to the first loudspeaker to convolution calculations so as to produce first and second echo cancel signals, respectively;

third and fourth filter sections that are provided corresponding to the first and second microphones for subjecting another audio signal supplied to the second loudspeaker to convolution calculations so as to produce third and fourth echo cancel signals, respectively;

a first subtracting section performs echo cancellation by subtracting said first and

third echo cancel signals from a collected audio signal of the first microphone; and

a second subtracting section performs echo cancellation by subtracting said second and fourth echo cancel signals from another collected audio signal of the second microphone, wherein

said stereo echo canceller further comprises a transfer function calculating section that respectively derives estimated errors of transfer functions of said four audio transfer systems based on a cross-spectrum calculation between mutually orthogonal two uncorrelated composite signals produced by applying a principal component analysis to stereo audio signals to be reproduced by said respective loudspeakers and respective echo cancel error signals obtained by subtracting the corresponding echo cancel signals from the collected audio signals of said two microphones, thereby to update filter characteristics of said first to fourth filter sections to values that cancel said estimated errors, respectively.

19. (original) A stereo echo canceller as recited in claim 18, further comprising:  
an orthogonalizing section applies a principal component analysis to the stereo audio signals inputted from said input section to produce said mutually orthogonal two uncorrelated composite signals; and

a main signal transmission system that transmits the stereo audio signals inputted from said input section to said respective loudspeakers without passing through said orthogonalizing section,

wherein said transfer function calculating section derives the estimated errors of the transfer functions of said four audio transfer systems based on the cross-spectrum calculation between the two uncorrelated composite signals produced by said

orthogonalizing section and the respective echo cancel error signals, and updates the filter characteristics of said first to fourth filter sections to the values that cancel said estimated errors, respectively.

20. (original) A stereo echo canceller as recited in claim 18, further comprising a double talk detecting section that is provided for detecting double talk in which a sound other than that reproduced by said loudspeakers is inputted into said microphones,

wherein said transfer function calculating section makes relatively longer an update period of said filter characteristics when said double talk is detected, while makes relatively shorter the update period of said filter characteristics when said double talk is not detected.

21. (original) A stereo sound transfer apparatus associated to two spaces each forming said four audio transfer systems, wherein the stereo echo canceller recited in claim 11 is arranged in each space, so that the stereo audio signals, which have been echo-canceled by said stereo echo cancellers, are transmitted between said two spaces.

Claims 22 - 40 (cancelled)

41. (original) An echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which audio signals of multi-channels having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones, and designed for performing an echo cancellation by subtracting an echo cancel signal from the audio signals collected by the respective microphone or from composite signals obtained by combining the collected audio



signals, the method comprising:

inputting a plurality of low-correlation audio signals which are obtained by suitably combining first audio signals of multi-channels and which have a lower correlation with each other than that among said first audio signals of multi-channels;

generating second audio signals of multi-channels having a correlation with each other by computation based on the inputted low-correlation audio signals;

feeding the generated second audio signals to the respective loudspeakers so as to reproduce audio sounds;

feeding the generated second audio signals or the inputted low-correlation audio signals to filters;

estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions based on the inputted low-correlation audio signals so as to set corresponding filter characteristics;

producing echo cancel signals by applying said set filter characteristics to the second audio signals or the low-correlation audio signals fed to the filters; and

subtracting said echo cancel signals from collected audio signals obtained by collecting the reproduced audio sounds by the microphones or from composite audio signals obtained by suitably combining said collected audio signals, thereby performing the echo cancellation.

42. (original) An echo cancel method as recited in claim 41, wherein the inputted low-correlation audio signals are obtained by adding or subtracting the first audio signals of multi-channels with each other.

43. (original) An echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which audio signals of multi-channels having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones, and designed for performing an echo cancellation by subtracting an echo cancel signal from the audio signals collected by the respective microphone or from composite signals obtained by combining the collected audio signals, the method comprising:

inputting a plurality of first low-correlation audio signals which are obtained by suitably combining first audio signals of multi-channels and which have a lower correlation with each other than that among said first audio signals of multi-channels;

generating second audio signals of multi-channels having a correlation with each other by computation based on the inputted first low-correlation audio signals;

feeding the generated second audio signals to the respective loudspeakers so as to reproduce audio sounds;

generating second low-correlation audio signals of multi-channels based on the generated second audio signals;

feeding the generated second audio signals or the generated second low-correlation audio signals to filters;

estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions based on the generated second low-correlation audio signals so as to set corresponding filter characteristics;

producing echo cancel signals by applying said set filter characteristics to the second audio signals or the second low-correlation audio signals fed to the filters; and

subtracting said echo cancel signals from collected audio signals obtained by collecting the reproduced audio sounds at the microphones or from composite audio signals obtained by suitably combining said collected audio signals, thereby performing the echo cancellation.

44. (original) An echo cancel method as recited in claim 43, wherein the inputted first low-correlation audio signals are obtained by adding or subtracting the first audio signals of multi-channels with each other.

45. (original) An echo canceller associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which audio signals of multi-channels having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones, and designed for performing an echo cancellation by subtracting an echo cancel signal from the audio signals collected by the respective microphone or from composite signals obtained by combining the collected audio signals, the echo canceller comprising:

an inputting section that inputs a plurality of low-correlation audio signals which are obtained by suitably combining first audio signals of multi-channels and which have a lower correlation with each other than that among said first audio signals of multi-channels;

a demodulating section that is provided for generating second audio signals of multi-channels having a correlation with each other by demodulating the inputted low-

correlation audio signals, and for feeding the generated second audio signals to the respective loudspeakers so as to reproduce audio sounds;

an estimating section that estimates individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions based on the inputted low-correlation audio signals so as to set corresponding filter characteristics;

a filter section that produces echo cancel signals by applying said set filter characteristics to the second audio signals or the low-correlation audio signals fed to the filter section; and

a subtracting section that subtracts said echo cancel signals from collected audio signals obtained by collecting the reproduced audio sounds at the microphones or from composite audio signals obtained by suitably combining said collected audio signals, thereby performing the echo cancellation.

46. (original) An echo canceller as recited in claim 45, wherein the inputted low-correlation audio signals are obtained by adding or subtracting the first audio signals of multi-channels with each other.

47. (original) An echo canceller associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which audio signals of multi-channels having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones, and designed for performing an echo cancellation by subtracting an echo cancel signal from the audio signals collected by the respective microphone or from composite signals obtained by combining the collected audio

signals, the echo canceller comprising:

an inputting section that inputs a plurality of first low-correlation audio signals which are obtained by suitably combining first audio signals of multi-channels and which have a lower correlation with each other than that among said first audio signals of multi-channels;

a demodulating section that is provided for generating second audio signals of multi-channels having a correlation with each other by demodulating the inputted first low-correlation audio signals, and for feeding the generated second audio signals to the respective loudspeakers so as to reproduce audio sounds;

an estimating section that is provided for generating second low-correlation audio signals of multi-channels based on the generated second audio signals, and for estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions based on the generated second low-correlation audio signals so as to set corresponding filter characteristics;

a filter section that produces echo cancel signals by applying said set filter characteristics to the second audio signals or the second low-correlation audio signals fed to the filter section; and

a subtracting section that subtracts said echo cancel signals from collected audio signals obtained by collecting the reproduced audio sounds at the microphones or from composite audio signals obtained by suitably combining said collected audio signals, thereby performing the echo cancellation.

48. (original) An echo canceller as recited in claim 47, wherein the inputted first

low-correlation audio signals are obtained by adding or subtracting the first audio signals of multi-channels with each other.

Claims 49 - 52 (cancelled).

53. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems,

the method comprising:

inputting multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers and collected by said microphones through the audio transfer systems;

estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said set filter characteristics to corresponding ones said the multi-channel audio signals to be reproduced by said respective loudspeakers or a plurality of composite signals obtained by suitably combining said multi-channel audio signals; and

subtracting said echo cancel signals from corresponding individual collected audio signals of said one or plurality of microphones, or from a plurality of composite signals obtained by suitably combining said individual collected audio signals, thereby performing echo cancellation,

wherein, reference signals are determined as a set of a plurality of low-

correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that among said multi-channel audio signals, for deriving said individual transfer functions of the respective audio transfer systems or said plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, thereby setting said corresponding filter characteristics.

54. (new) A multi-channel echo cancel method as recited in claim 53, wherein calculation is conducted for respectively deriving the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions with using the set of the plurality of the low-correlation composite signals as the reference signals, such that the calculation is based on a cross-spectrum calculation between the plurality of the low-correlation composite signals and the individual collected audio signals of the microphones, or the plurality of the composite signals obtained by suitably combining said individual collected audio signals.

55. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which multi-channel audio signals having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones,

the method comprising: estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions so as to set

corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said set filter characteristics to corresponding ones of said multi-channel audio signals to be reproduced by said respective loudspeakers or a plurality of composite signals obtained by suitably combining said multi-channel audio signals; and

subtracting said echo cancel signals from corresponding individual collected audio signals of said one or plurality of microphones, or from a plurality of composite signals obtained by suitably combining said individual collected audio signals, thereby performing echo cancellation,

wherein, reference signals are determined as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that among said multi-channel audio signals, for deriving said individual transfer functions of the respective audio transfer systems or said plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, thereby setting said corresponding filter characteristics,

wherein calculation is conducted for respectively deriving the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions with using the set of the plurality of the low-correlation composite signals as the reference signals, such that the calculation is based on a cross-spectrum calculation between the plurality of the low-correlation composite signals and the individual collected audio signals of the microphones, or the plurality of the composite



signals obtained by suitably combining said individual collected audio signals, and  
wherein

the calculation of respectively deriving the individual transfer functions of said plurality of the audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions is performed by combining said multi-channel audio signals through addition or subtraction to produce a plurality of low-correlation composite signals having a lower correlation with each other than that among said multi-channel audio signals, deriving cross spectra by the cross-spectrum calculation between said plurality of the low-correlation composite signals and the individual collected audio signals of the microphones, or the plurality of the composite signals obtained by suitably combining said individual collected audio signals, and ensemble-averaging each of the cross spectra in a predetermined time period for deriving the individual transfer functions of said plurality of the audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions.

56. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems,

the method comprising:

inputting multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers and collected by said microphones through the audio transfer systems;

estimating individual transfer functions of said plurality of said audio

transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said set filter characteristics to corresponding ones of said multi-channel audio signals to be reproduced by said respective loudspeakers or a plurality of composite signals obtained by suitably combining said multi-channel audio signals; and

subtracting said echo cancel signals from corresponding individual collected audio signals of said one or plurality of microphones, or from a plurality of composite signals obtained by suitably combining said individual collected audio signals, thereby performing echo cancellation,

wherein, reference signals are determined as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that among said multi-channel audio signals, for deriving estimated errors of said individual transfer functions of the respective audio transfer systems or said plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, thereby updating said corresponding filter characteristics to values that cancel the estimated errors.

57. (new) A multi-channel echo cancel method as recited in claim 56, wherein calculation is conducted for respectively deriving the estimated errors of the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer

functions with using the set of the plurality of the low-correlation composite signals as the reference signals, such that the calculation is based on a cross-spectrum calculation between the plurality of the low-correlation composite signals and echo cancel error signals obtained by subtracting the echo cancel signals from the corresponding individual collected audio signals of said one or plurality of the microphones, or from the plurality of the composite signals obtained by suitably combining said individual collected audio signals.

58. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which multi-channel audio signals having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones,

the method comprising: estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said set filter characteristics to corresponding ones of said multi-channel audio signals to be reproduced by said respective loudspeakers or a plurality of composite signals obtained by suitably combining said multi-channel audio signals; and

subtracting said echo cancel signals from corresponding individual collected audio signals of said one or plurality of microphones, or from a plurality of composite signals obtained by suitably combining said individual collected audio

signals, thereby performing echo cancellation,

wherein, reference signals are determined as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that among said multi-channel audio signals, for deriving estimated errors of said individual transfer functions of the respective audio transfer systems or said plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, thereby updating said corresponding filter characteristics to values that cancel the estimated errors,

wherein calculation is conducted for respectively deriving the estimated errors of the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions with using the set of the plurality of the low-correlation composite signals as the reference signals, such that the calculation is based on a cross-spectrum calculation between the plurality of the low-correlation composite signals and echo cancel error signals obtained by subtracting the echo cancel signals from the corresponding individual collected audio signals of said one or plurality of the microphones, or from the plurality of the composite signals obtained by suitably combining said individual collected audio signals, and

wherein the calculation of respectively deriving the estimated errors of the individual transfer functions of said plurality of the audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions is performed by combining said multi-channel audio signals through

addition or subtraction to produce a plurality of low-correlation composite signals having a lower correlation with each other than that among said multi-channel audio signals, deriving cross spectra by the cross-spectrum calculation between said plurality of the low-correlation composite signals and the echo cancel error signals obtained by subtracting the echo cancel signals from the corresponding individual collected audio signals of said one or plurality of the microphones, or from the plurality of the composite signals obtained by suitably combining said individual collected audio signals, and ensemble-averaging each of the cross spectra in a predetermined time period for deriving the estimated errors of the individual transfer functions of said plurality of the audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions.

59. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which multi-channel audio signals having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones,

the method comprising: estimating individual transfer functions of said plurality of said audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said set filter characteristics to corresponding ones of said multi-channel audio signals to be reproduced by said respective loudspeakers or a plurality of composite signals obtained

by suitably combining said multi-channel audio signals; and

subtracting said echo cancel signals from corresponding individual collected audio signals of said one or plurality of microphones, or from a plurality of composite signals obtained by suitably combining said individual collected audio signals, thereby performing echo cancellation,

wherein, reference signals are determined as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that among said multi-channel audio signals, for deriving estimated errors of said individual transfer functions of the respective audio transfer systems or said plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, thereby updating said corresponding filter characteristics to values that cancel the estimated errors, and

wherein the correlation between said plurality of said low-correlation composite signals is detected and, when a value of said correlation is no less than a predetermined value, the updating of said filter characteristics is suspended.

60. (new) A multi-channel sound transfer method associated to two spaces each forming said plurality of said audio transfer systems, wherein the multi-channel echo cancel method recited in claim 53 is carried out respectively in the two spaces, so that the multi-channel audio signals, which have been echo-canceled by performing said method, are transmitted between said two spaces.

61. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones

for forming a plurality of audio transfer systems,

the method comprising:

inputting multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers and collected by said microphones through the audio transfer systems;

estimating transfer functions of said plurality of said audio transfer systems so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said filter characteristics to corresponding multi-channel audio signals to be reproduced by said respective loudspeakers; and

subtracting said echo cancel signals from corresponding collected audio signals of said one or plurality of said microphones, thereby performing echo cancellation,

wherein a principal component analysis is applied to said multi-channel audio signals to produce a plurality of uncorrelated composite signals that are orthogonal to each other, and the transfer functions of the respective audio transfer systems are respectively derived using a set of said plurality of said uncorrelated composite signals as reference signals, thereby to set the corresponding filter characteristics.

62. (new) A multi-channel echo cancel method associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems,

the method comprising:

inputting multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers and collected by said microphones through the audio transfer systems;

estimating transfer functions of said plurality of said audio transfer systems so as to set corresponding filter characteristics, respectively;

producing echo cancel signals respectively by applying said filter characteristics to corresponding multi-channel audio signals to be reproduced by said respective loudspeakers; and

subtracting said echo cancel signals from corresponding collected audio signals of said one or plurality of said microphones, thereby performing echo cancellation,

wherein a principal component analysis is applied to said multi-channel audio signals to produce a plurality of uncorrelated composite signals that are orthogonal to each other, and estimated errors of the transfer functions of the respective audio transfer systems are respectively derived using a set of said plurality of said uncorrelated composite signals as reference signals, thereby to update said corresponding filter characteristics to values that cancel said estimated errors.

63. (new) A transfer function calculation apparatus being associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems, and being capable of estimating individual transfer functions of said plurality of audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions, the apparatus comprising:



an input section that inputs multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers and collected by said microphones through the audio transfer systems;

a providing section that provides reference signals as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that between said multi-channel audio signals; and

a calculation section that estimates the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions based on the determined reference signals.

64. (new) A transfer function calculation apparatus as recited in claim 63, wherein the calculation section respectively derives the individual transfer functions of the respective audio transfer systems or the plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, using as the reference signals the set of the plurality of the low-correlation composite signals, such that calculation of respectively deriving the individual transfer functions of the respective audio transfer systems or the plurality of said composite transfer functions obtained by suitably combining said individual transfer functions is based on a cross-spectrum calculation between the plurality of said low-correlation composite signals and individual collected audio signals of the microphones, or a plurality of composite signals obtained by suitably combining said individual collected audio signals.

65. (new) A transfer function calculation apparatus being associated to a

space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems through which multi-channel audio signals having a correlation with each other are reproduced by said respective loudspeakers and are collected by said microphones, and being capable of estimating individual transfer functions of said plurality of audio transfer systems or a plurality of composite transfer functions obtained by suitably combining said individual transfer functions, the apparatus comprising:

a providing section that provides reference signals as a set of a plurality of low-correlation composite signals which correspond to signals obtained by suitably combining said multi-channel audio signals and which have a lower correlation with each other than that between said multi-channel audio signals; and

a calculation section that estimates the individual transfer functions of the respective audio transfer systems or the plurality of the composite transfer functions obtained by suitably combining said individual transfer functions based on the determined reference signals,

wherein the calculation section respectively derives the individual transfer functions of the respective audio transfer systems or the plurality of said composite transfer functions obtained by suitably combining said individual transfer functions, using as the reference signals the set of the plurality of the low-correlation composite signals, such that calculation of respectively deriving the individual transfer functions of the respective audio transfer systems or the plurality of said composite transfer functions obtained by suitably combining said individual transfer functions is based on a cross-spectrum calculation between the plurality of said low-correlation composite

signals and individual collected audio signals of the microphones, or a plurality of composite signals obtained by suitably combining said individual collected audio signals, and

wherein the providing section combines said multi-channel audio signals through addition or subtraction to produce said plurality of said low-correlation composite signals having a lower correlation with each other than that between said multi-channel audio signals, such that the calculation section derives cross spectra based on said cross-spectrum calculation between said plurality of said low-correlation composite signals and the individual collected audio signals of the microphones, or the plurality of composite signals obtained by suitably combining said individual collected audio signals, and ensemble-averages the respective cross spectra in a predetermined time period for deriving the individual transfer functions of said plurality of said audio transfer systems or the plurality of said composite transfer functions obtained by suitably combining said individual transfer functions.

66. (new) A transfer function calculation apparatus as recited in claim 64, wherein the providing section produces a plurality of uncorrelated composite signals mutually orthogonal as the reference signals by applying a principal component analysis to said multi-channel audio signals, such that the calculation section derives cross spectra based on said cross-spectrum calculation between said plurality of said uncorrelated composite signals and the individual collected audio signals of the microphones, and ensemble-averages the respective cross spectra in a predetermined time period for deriving the individual transfer functions of said plurality of said audio transfer systems.

67. (new) A transfer function calculation apparatus being associated to a space provided therein with two loudspeakers and two microphones for forming four audio transfer systems, and being capable of estimating individual transfer functions of said four audio transfer systems, the apparatus comprising:

a section that inputs stereo audio signals from an outside, which are reproduced by said respective loudspeakers and collected by said respective microphones;

a section that produces mutually orthogonal two uncorrelated composite signals by applying a principal component analysis to said stereo audio signals; and

a section that estimates said individual transfer functions of said four audio transfer systems using a set of said two uncorrelated composite signals as reference signals.

68. (new) An echo canceller being associated to a space provided therein with a plurality of loudspeakers and one or a plurality of microphones for forming a plurality of audio transfer systems, the echo canceller comprising:

an input section that inputs multi-channel audio signals from an outside, which have a correlation with each other, and which are reproduced by said respective loudspeakers as audio sounds having correlation with each other;

a generating section that generates reference signals as a set of low-correlation composite signals based on said multi-channel audio signals, the low-correlation composite signals having a lower correlation with each other than that among said multi-channel audio signals;

an estimating section that estimates individual transfer functions of the

respective audio transfer systems or composite transfer functions obtained by suitably combining said individual transfer functions based on the generated reference signals so as to set filter characteristics;

a filter section that produces echo cancel signals by applying said set filter characteristics to the multi-channel audio signals inputted from the outside or composite audio signals generated based on the inputted multi-channel audio signals; and

a subtracting section that subtracts said echo cancel signals from collected audio signals obtained by collecting the reproduced audio sounds having correlation with each other at the microphones or from composite audio signals obtained based on said collected audio signals, thereby performing the echo cancellation.